



## **Mineralogy and geochemical trapping of CO<sub>2</sub> in an Italian carbonatic deep saline aquifer: preliminary results**

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CO<sub>2</sub> Capture & Storage (CCS) is presently one of the most promising technologies for reducing anthropogenic emissions of CO<sub>2</sub>. Among the several potential geological CO<sub>2</sub> storage sites, e.g. depleted oil and gas field, unexploitable coal beds, saline aquifers, the latter are estimated to have the highest potential capacity (350-1000 Gt CO<sub>2</sub>) and, being relatively common worldwide, a higher probability to be located close to major CO<sub>2</sub> anthropogenic sources. In these sites CO<sub>2</sub> can safely be retained at depth for long times, as follows: *a*) physical trapping into geologic structures; *b*) hydrodynamic trapping where CO<sub>2(aq)</sub> slowly migrates in an aquifer, *c*) solubility trapping after the dissolution of CO<sub>2(aq)</sub> and *d*) mineral trapping as secondary carbonates precipitate. Despite the potential advantages of CO<sub>2</sub> geo-sequestration, risks of CO<sub>2</sub> leakage from the reservoir have to be carefully evaluated by both monitoring techniques and numerical modeling used in "CO<sub>2</sub> analogues", although seepage from saline aquifers is unlikely to be occurring. The fate of CO<sub>2</sub> once injected into a saline aquifer can be predicted by means of numerical modelling procedures of geochemical processes, these theoretical calculations being one of the few approaches for investigating the short-long-term consequences of CO<sub>2</sub> storage. This study is focused on some Italian deep-seated (>800 m) saline aquifers by assessing solubility and mineral trapping potentiality as strategic need for some feasibility studies that are about

to be started in Italy. Preliminary results obtained by numerical simulations of a geochemical modeling applied to an off-shore Italian carbonatic saline aquifer potential suitable to geological CO<sub>2</sub> storage are here presented and discussed. Deep well data, still covered by industrial confidentiality, show that the saline aquifer, includes six Late Triassic-Early Jurassic carbonatic formations at the depth of 2500-3700 m b.s.l. These formations, belonging to Tuscan Nappe, consist of porous limestones (mainly calcite) and marly limestones sealed, on the top, by an effective and thick cap-rock (around 2500 m) of clay flysch belonging to the Liguride Units. The evaluation of the potential geochemical impact of CO<sub>2</sub> storage and the quantification of water-gas-rock reactions (solubility and mineral trapping) of injection reservoir have been performed by the PRHEEQC (V2.11) Software Package via corrections to the code default thermodynamic database to obtain a more realistic modelling. The main modifications to the Software Package are, as follows: *i*) addition of new solid phases, *ii*) variation of the CO<sub>2</sub> supercritical fugacity and solubility under reservoir conditions, *iii*) addition of kinetic rate equations of several minerals and *iv*) calculation of reaction surface area. Available site-specific data include only basic physical parameters such as temperature, pressure, and salinity of the formation waters. Rocks sampling of each considered formation in the contiguous in-shore zones was carried out. Mineralogy was determined by X-Ray diffraction analysis and Scanning Electronic Microscopy on thin sections. As chemical composition of the aquifer pore water is unknown, this has been inferred by batch modeling assuming thermodynamic equilibrium between minerals and a NaCl equivalent brine at reservoir conditions (up to 135°C and 251 atm). Kinetic modelling was carried out for isothermal conditions (135°C), under a CO<sub>2</sub> injection constant pressure of 251 atm, between: *a*) bulk mineralogy of the six formations constituting the aquifer, and *b*) pre-CO<sub>2</sub> injection water. The kinetic evolution of the CO<sub>2</sub>-rich brines interacting with the host-rock minerals performed over 100 years after injection suggests that solubility trapping is prevailing in this early stage of CO<sub>2</sub> injection. Further and detailed multidisciplinary studies on rock properties, geochemical and micro seismic monitoring and 3D reservoir simulation are necessary to better characterize the potential storage site and assess the CO<sub>2</sub> storage capacity.